CLAIMS

We claim:

1. A particle beam device which operates upon a test subject, wherein at least a portion of the particle beam device is maintained in a vacuum, the particle beam device comprising at least:

a particle generator;

at least a first particle focusing device, the particle generator and the at least first particle focusing device together being formed into a first particle beam column;

a plurality of air bearings to support the particle beam column and to permit the particle beam column to move in a nearly frictionless manner across a top surface of a first support table;

a sample holding station located within the top surface of the first support table, the sample holding station holding at least a first surface of a test object in an essentially co-planar relationship with the top surface of the first support table, wherein the sample holding station comprises at least a well in the top surface of the first support table for receiving the test object therein, and wherein the sample holding station further comprises a plurality of lifter assemblies and a chuck, the lifter assemblies in a first extended position receiving the test object and in a second, compressed position holding the test object in proximity to the chuck so that the chuck can hold the test object, the compressed position being such that the top surface of the test object is held in a co-planar relationship with the top surface of the first support table; and

an air bearing leveling tool for placing the test object into the second, compressed position, the air bearing leveling tool having a plurality of air bearings which are applicable to the top surface of the test object to thereby force the test object and the lifter assemblies into the second, compressed position.

2. The particle beam device of claim 1 wherein a staged vacuum seal is fitted to the particle beam column between the at least first particle focusing device and the top surface of the first support table, the staged vacuum seal creating a plurality of concentric, reduced pressure zones around the first particle beam column.

3. The particles beam device of claim 2 wherein the staged vacuum seal is comprised of a plurality of nested circles, the innermost reduced pressure zone having a circular cross section and succeeding reduced pressure zones have a torroidal cross section surrounding the innermost circular reduced pressure zone.

4. The particle beam device of claim 3 wherein the innermost circular reduced pressure zone has a first predefined air pressure that permits operation of the particle beam within the innermost circular reduced pressure zone.

5. The particle beam device of claim 4 wherein each succeeding torroidal reduced pressure zone has an air pressure greater than the preceding reduced pressure zone.

6. The particle beam device of claim 1 wherein the test object comprises a semiconductor wafer of first predetermined diameter and the well of the sample holding station is circular and has a second predetermined diameter at least equal to the first predetermined diameter.

7. The particle beam device of claim 6 the plurality of air bearings are fixed into a rigid frame, an active, gas bearing surface of each of the air bearings being held in a co-planar relationship with all the other active, gas bearing surfaces of the air bearings, the frame having a predetermined diameter greater that the semiconductor wafer's diameter, the active, gas bearing surfaces being applied to the top surface of the semiconductor wafer and forcing the wafer and the lifter assemblies into the second, compressed position during operation of the particle beam device.

8. The particle beam device of claim 7 wherein the lifter assemblies are filled with a low melting point metal alloy, heat being applied to the lifter assemblies when the lifter assemblies are required to move from the first position to the second position and when the lifter assemblies are required to move from the second position to the first position, heat being removed and the metal alloy solidifying, fixing the lifter assemblies into position at all other times.

9. A particle beam device which operates upon a test object, comprising:

a particle beam imaging column for directing a particle beam towards a test object;

a sample holding station for holding at least a first surface of the test object in an essentially co-planar relationship with a top surface of a support, wherein the sample holding station comprises at least a well in the top surface of the support for receiving the test object therein, and wherein the sample holding station further comprises a plurality of lifter assemblies, the lifter assemblies in a first, extended position receiving the test object and in a second, compressed position holding the test object such that the top surface of the test object is held in a co-planar relationship with the top surface of the support; and

an air bearing leveling tool for placing the test object into the second, compressed position, the air bearing leveling tool having a plurality of air bearings which are applicable to the top surface of the test object to thereby force the test object and the lifter assemblies into the second, compressed position.

10. The particle beam device of claim 9 wherein the test object comprises a semiconductor wafer of first predetermined diameter and the well of the sample holding station is circular and has a second predetermined diameter at least equal in size to the first predetermined diameter.

11. The particle beam device of claim 9 wherein the plurality of air bearings are fixed into a rigid frame, an active, gas bearing surface of each of the air bearings being held in a co-planar relationship with all the other active, gas bearing surfaces of the air bearings, the frame having a predetermined size greater that the test object's size, the active, gas bearing surfaces being applied to the top surface of the test object and forcing the test object and the lifter assemblies into the second, compressed position.

12. The particle beam device of claim 11 wherein the lifter assemblies are filled with a low melting point metal alloy, heat being applied to the lifter assemblies when the lifter assemblies are required to move from the first position to the second position and when the lifter assemblies are required to move from the second position to the first position, heat being removed and the metal alloy solidifying, fixing the lifter assemblies into position at all other times.

13. A method of using a particle beam device to inspect or measure a test object, the particle beam device having a particle beam imaging column for directing a particle beam towards the test object, a sample holding station for holding at least a first surface of a test object in an essentially co-planar relationship with a top surface of a support, wherein the sample holding station comprises at least a well in the top surface of the support for receiving the test object therein, and wherein the sample holding station further comprises a plurality of lifter assemblies, the lifter assemblies in a first extended position receiving the test object and in a second, compressed position holding the test object such that the top surface of the test object is held in a co-planar relationship with the top surface of the support, and an air bearing leveling tool for placing the test object into the second, compressed position, the air bearing leveling tool having a plurality of air bearings which are applicable to the top surface of the test object to thereby force the test object and the lifter assemblies into the second, compressed position, the method comprising the steps of:

placing a first surface of the test object in a co-planar relationship with the first surface of the support by moving the air bearing leveling tool and the test object towards each other so that the air bearing of the leveling tool contact the test object and force the test object and lift assemblies into the second, compressed position; and

moving the particle beam generated by the particle beam imaging column over the first surface of the test object while the first surface is held in its co-planar relationship with the first surface of the support.

14. The method of claim 13 wherein a plurality of air bearings are attached to the particle beam device and permit its substantially frictionless motion of the particle beam imaging column over the first surface, the method further comprising moving the particle beam imaging column over the first surface of the test object, wherein the movement is substantially frictionless.

15. The method of claim 13 wherein a staged seal vacuum generator is attached to the particle beam device so that the particle beam device will continue to operate in a substantial vacuum even while moving over the first surface of the test object.

16. The method of claim 15 wherein the first surface of the test object comprises a first, device-fabrication side of a semiconductor wafer.

17. A particle beam device which operates upon a test object, comprising:

a particle beam imaging column for directing a particle beam towards a test object;

a sample holding station for holding at least a first surface of the test object in an essentially co-planar relationship with a top surface of a support, wherein the sample holding station comprises at least a well in the top surface of the support for receiving the test object therein, and wherein the sample holding station further comprises a plurality of lifter assemblies, the lifter assemblies in a first, extended position receiving the test object and in a second, compressed position holding the test object such that the top surface of the test object is held in a co-planar relationship with the top surface of the support;

an air bearing leveling tool for placing the test object into the second, compressed position, the air bearing leveling tool having a plurality of air bearings which are applicable to the top surface of the test object to thereby force the test object and the lifter assemblies into the second, compressed position;

a vacuum chamber maintained at a very high DC electrical potential, the vacuum chamber containing the sample holding station;

a vacuum pump maintained at substantially a ground potential and configured to create a vacuum within the vacuum chamber; and

a voltage isolating passageway that connects the vacuum chamber and the vacuum pump, the voltage isolating passageway including,

a passageway having two openings with vacuum fitting seals, one of the openings configured to be connected to the vacuum chamber and the other opening configured to be connected to the vacuum pump such that a vacuum can be sustained within the passageway, wherein charged particles having a certain level of potential energy travel through the passageway;

a semi-conductive material layer that coats an inner surface of the passageway, the semi-conductive material layer acting to absorb at least some of the charged particles that come into physical contact with the inner surface of the passageway; and

a first and a second magnet positioned along opposite and exterior surfaces of the passageway wherein the first and second magnets impose a magnetic field in a transverse direction with respect to a lengthwise axis of the passageway, the transverse magnetic field tending to reduce the potential energy of the charged particles that travel through the passageway.

18. A voltage-isolating passageway as recited in claim 17 wherein the semi-conductive material layer has resistance of at least 60 Mega-ohms Square.